

Submitted by FR and GER

Informal Document – ACSF-25-08




# ALKS Technical requirements for testing

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-  Functional Test
-  Dynamic Driving Function

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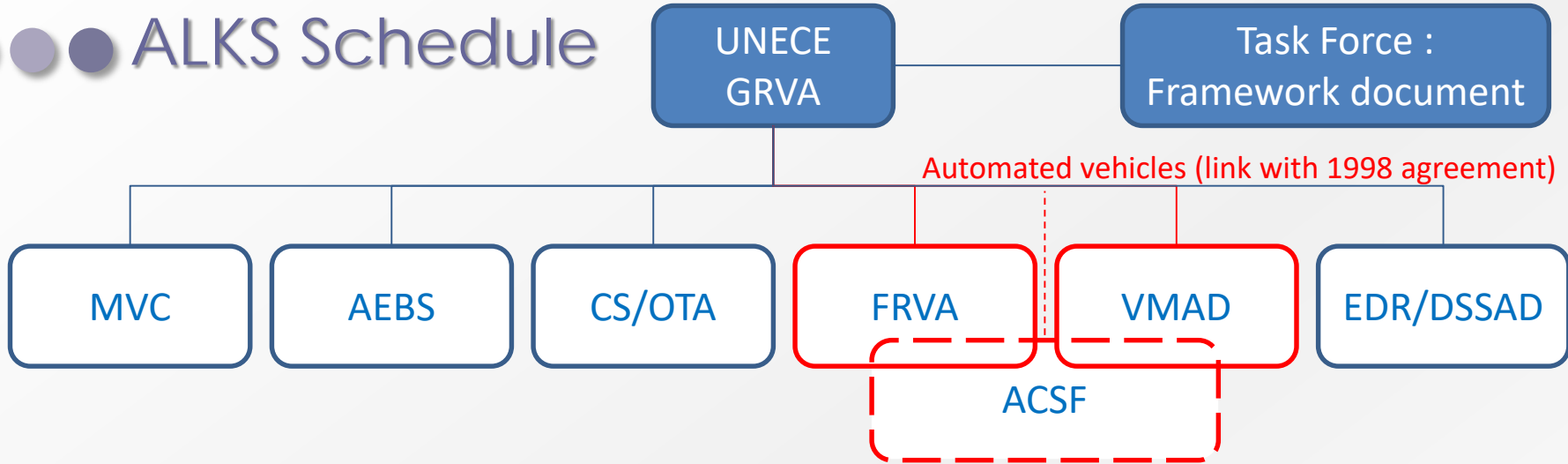
## *Methodology*

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-  Functional Test
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# ALKS Schedule



## Automatically Commanded Steering Function

- Scope of application : Automated Lane Keeping System (ALKS)
  - Highway configuration
  - Traffic jam assist 0 – 60kph
  - M1 category (keeping other categories in scope)
  - Automatisisation level 3

### 2019 December status

- Functional requirements quite frozen
- « Conventional testing protocols » under definition by dedicated group led by FR & GER (draft proposal)
- Dedicated preliminary meeting between experts planned on January 7th (draft proposal)
- Outcoming draft proposal will be reviewed by VMAD experts during 05th session
- Testing protocols will be continued based on VMAD feedbacks in ACSF 25th

Introduction

Methodology




Test Scenarios

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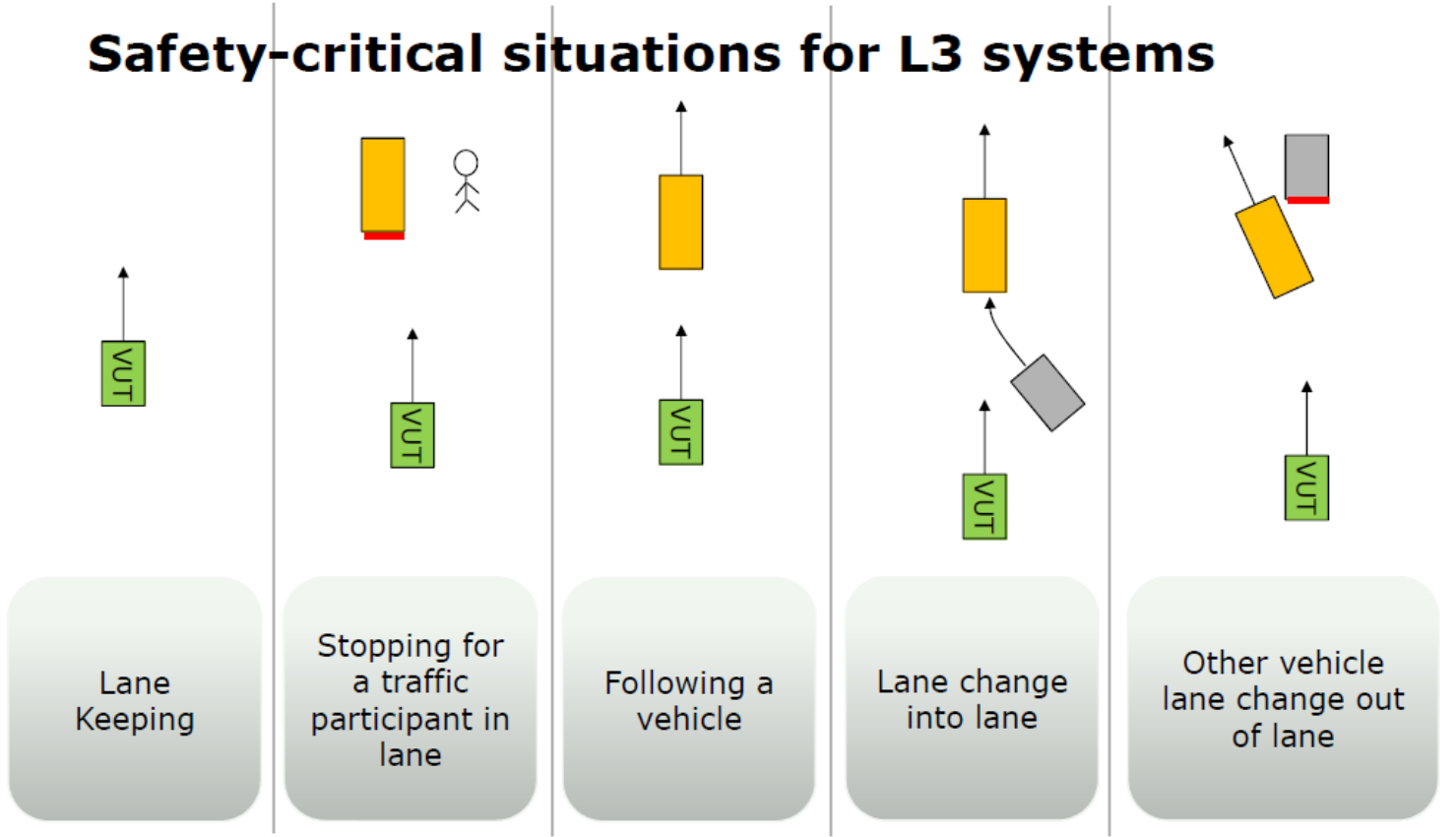
## *Test Scenarios*

-  Functional Test
-  Dynamic Driving Function

Global approach



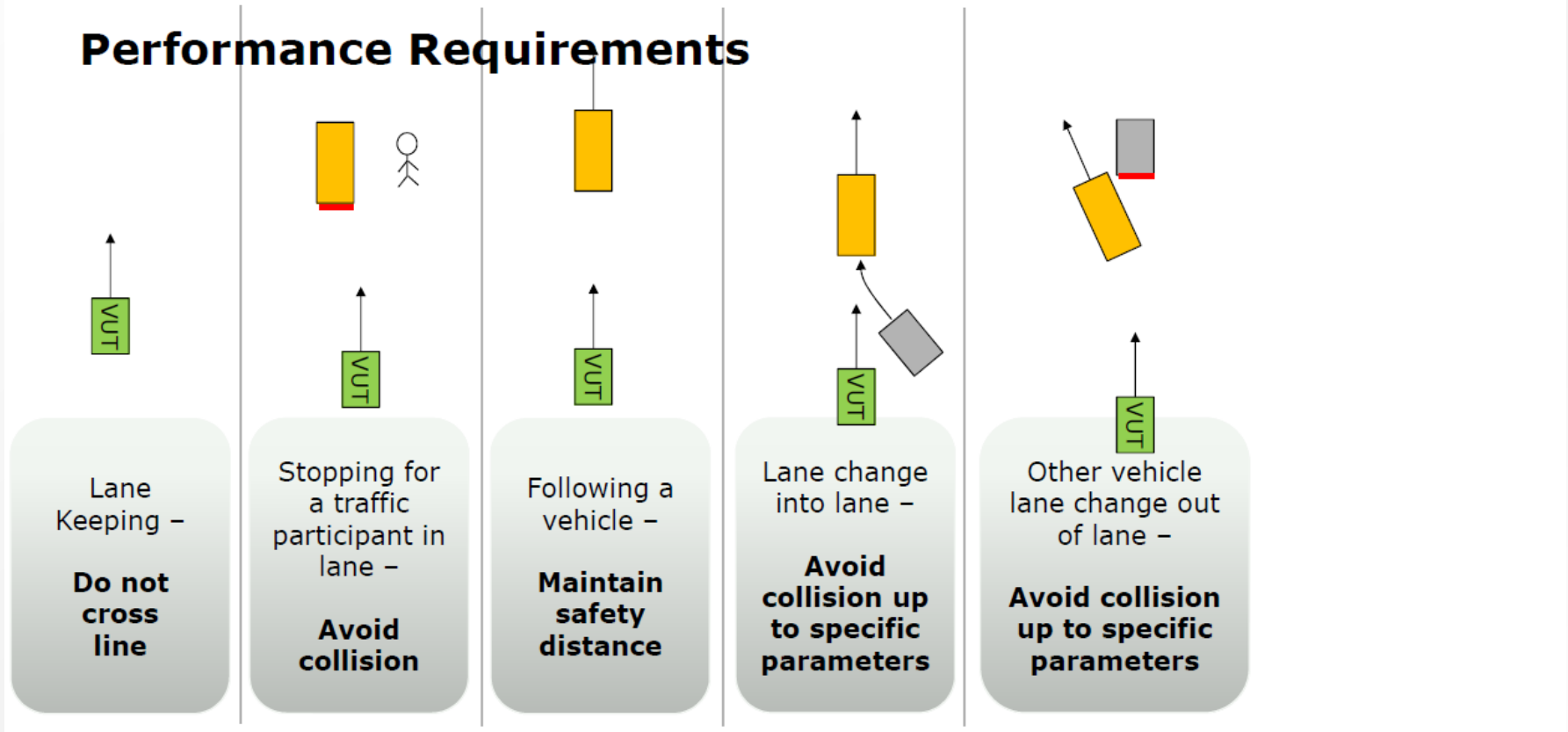
### Safety-critical situations for L3 systems



# Global approach



## Performance Requirements



# Different Situations

➤ Depending on Test Parameters 3 different situations:

- Regular Maneuver [vehicle breaking needs  $<5\text{m/s}^2$ ]
- Emergency Maneuver [vehicle breaking needs  $>5\text{m/s}^2$ ]
- Not avoidable situation (control strategy to be maintained)

Updated from  $4\text{m/s}^2$  to  $5\text{m/s}^2$  to be aligned with the imminent collision as considered by UNECE n°152 on AEBs M1-N1.

➤ Depending of the situation different pass/fail criteria

➤ Example (parameters just as an example):

**Prevents ego-vehicle-caused accidents**

Situation	Regular maneuver [ $<4\text{ m/s}^2$ ]	Emergency maneuver [ $>4\text{ m/s}^2$ ]	>
Lane Following	Never leave lane	-	<b>Do not change strategy (do the best avoidance not required)</b>
Stopped traffic participant in lane (visible!)	Stop in all situations	-	
Following a lead vehicle	Maintain safety distance up to $[4]\text{ m/s}^2$	<b>Avoid</b> collision $[4...10]\text{ m/s}^2$	
Lane change into lane	<b>Avoid</b> collision $v_{rel} < [20]\text{ km/h}$ , $TTC > [2.0]$ , $v_{lat} < [3.5]\text{ m/s}$	<b>Avoid</b> collision $v_{rel} < [20]\text{ km/h}$ , $TTC > [1.0]$ , $v_{lat} < [3.5]\text{ m/s}$	
Lane change out of lane	<b>Avoid</b> collision $v_{rel} < [20]\text{ km/h}$ , $TTC > [2.0]$ , $v_{lat} < [3.5]\text{ m/s}$	<b>Avoid</b> collision $v_{rel} < [20]\text{ km/h}$ , $TTC > [1.0]$ , $v_{lat} < [3.5]\text{ m/s}$	



## ●●● Fixed or random Parameters ?

- ⇒ *Random selection for the Scenarios to test, the parameters or both? First approach to be further discussed :*
  - ⇒ *Imposed scenarios : each scenario of the current annex shall be tested*
  - ⇒ *Imposed parameters sets : for each scenario of the previous point and for each target (if applicable), a minimum of two parameter sets in accordance with the specified parameters and corresponding to each intended situation shall be tested (if applicable) → regular maneuver, emergency maneuver, not avoidable)*
  - ⇒ *Random scenarios and parameters : in addition to the previous point, a minimum of [10] additional tests shall be performed with different parameters sets or scenarios not already covered in this annex.*
  - ⇒ *Critical scenarios and parameters : included into the minimum of [10] tests from the previous random scenarios and parameters, the technical service can defined specific scenarios or parameters tests in order to adapt it to the dedicated system to be approved.*

# Random Parameters

- Random selection of the test parameter sets (speed, lateral acceleration, offset, TTC, etc.)
- Positioning of the test parameter sets regarding the intended situation (Regular maneuver, Emergency maneuver, not avoidable).
- Example Cut In Scenario (parameters are not frozen, methodology example) :

Test configuration	TTC Lanechange [s]	a lateral [m/s <sup>2</sup> ]	t Lanechange [s]	d Lanechange [m]	d Lateral [m]	v relative [km/h]	v ALKS [km/h]	TTC intrusion [s]	Situation	Pass/fail criteria Avoidance?
1	2,5	2	2,65	7,35	3,5	40	50	1,18	Not avoidable	No
2	3,5	1	3,74	10,39	3,5	40	50	1,63	Regular maneuver	Yes
3	4	1	3,74	10,39	3,5	40	50	2,13	Regular maneuver	Yes
4	2,5	3	2,16	6	3,5	40	50	1,42	Emergency maneuver	Yes

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# Test scenarios : synthesis matrix

Paragraph	Topic	Annex X		Annex Y CEL	DSSAD	Remarks
		Observation	Measure Test protocol (Track test)			
2.1	General requirements				(X)	
2.1.1	Dedicated means to activate and deactivate	X 5.4				Simple specification
2.1.2	Default status of new engine start/stop	X 5.4				Simple specification
2.1.3a	System active if driver is in driver seat & belt is fastened	X 5.4				Simple specification
2.1.3b	System active if driver is available	(X)	X 5.4			See 2.6. Criteria for driver availability very depending on the manufacturer; possible to confirm by simple tests ?
2.1.3c	System active if no failure	X 5.4				Simple specification
2.1.3d	System active if DSSAD is operational	X 5.4			(X)	Simple specification See 2.12.1.
2.1.3e	System active if environment and infrastructure OK			(X)	(X)	Option for real driving 'Environment and infrastructure' condition very depending on the manufacturer; assessment under CEL is adequate ?
2.1.3f	System active if vehicle is on a right road			(X)	(X)	Option for real driving Simple tests on test track is difficult; assessment under CEL is adequate ?
2.1.4a	Same dedicated means to activate and deactivate manually	X 5.4				Simple specification
2.1.4b	Means of deactivating protected against unintentional system	X 5.4			X	Simple specification
2.1.4c	At time of deactivation driver must be in lateral control	X 5.4			X	Simple specification
2.1.5.1	Deactivation by input to driving controls	X 5.4				See 2.4.6.
2.1.5.2	Deactivation during an ongoing transition demand	X 5.4				See 2.4.6. & 2.6.3.
2.1.5.3	Deactivation during an ongoing emergency manoeuvre		(X)	(X)	(X)	See 2.10.1. Simple tests on test track is difficult; assessment under CEL is adequate. ?
2.1.5.4	Deactivation in case of severe failure	X 5.4			(X)	
2.1.6	At time of deactivation the system shall not provide any continuous control of either longitudinal or lateral movement of the vehicle	(X)		X 5.5.1		See 2.4.6.1.
2.1.7	Indication of any deactivation	(X)		X 5.5.1		See 2.8.2.3/2.4.6.1.
2.1.8.1	Override by a driver input to the steering control	(X)		X 5.5.1	(X)	
2.1.8.2	Override by a driver input to the braking control	(X)		X 5.5.1		
2.1.8.3	Override by a driver input to the accelerator control	(X)		X 5.5.1		
2.1.8.4	Indication of a transition demand by any driver input to the accelerator or brake control	(X)		X 5.5.1		
2.1.8.5	Reduction or suppression of the effect of the driver input on any control in case the system has detected an imminent collision				X	
2.1.8.6	ALIS control strategies in case of a severe vehicle failure or a severe ALIS failure				X	
2.1.9	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.1	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.2	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3	X	Option for real driving
2.1.9.3	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.4	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.5	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.6	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.7	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.8	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.9	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.10	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.11	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.12	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.13	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.14	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.15	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.16	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.17	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.18	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.19	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.20	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.21	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.22	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.23	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.24	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.25	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.26	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.27	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.28	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.29	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.30	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.31	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.32	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.33	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.34	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.35	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.36	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.37	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.38	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.39	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.40	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.41	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.42	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.43	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.44	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.45	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.46	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.47	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.48	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.49	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.50	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.51	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.52	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.53	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
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2.1.9.55	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.56	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.57	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.58	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.59	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.60	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.61	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.62	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.63	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.64	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.65	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.66	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.67	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.68	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.69	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.70	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.71	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.72	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.73	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.74	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.75	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.76	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.77	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.78	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.79	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.80	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.81	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.82	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.83	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.84	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.85	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.86	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.87	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.88	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.89	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.90	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.91	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.92	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.93	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.94	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.95	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.96	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.97	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.98	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.99	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		
2.1.9.100	Dynamic driving task of ALIS	(X)		X 5.5.1.2/5.5.2.3.3		

- ⇒ Exhaustive list of the already defined functional requirements
- ⇒ Split between Annex X ("conventional testing protocols"), Annex Y (CEL), DSSAD
- ⇒ Focus on annex X : tests protocols already drafted in green, (X) have to be further discussed.

# Functional Test

Paragraphs	Topic
2.4.1	Dedicated means to activate and deactivate
2.4.2	Default status of new engine start/run
2.4.3a	System active if driver is in driver seat & belt is fastened
2.4.3b	System active if driver is available
2.4.3c	System active if no failure
2.4.3d	System active if DSSAD is operational
2.4.4a	Same dedicated means to activate and deactivate manually
2.4.4b	Means of deactivating protected against unintentional action
2.4.4c	At time of deactivation driver must be in lateral control
2.4.5.1	Desactivation by input to driving controls
2.4.5.2	Desactivation during an ongoing transition demand
2.4.5.4	Desactivation in case of severe failure
2.6.1.	Driver presence
2.6.2.1.	Criteria for deeming driver availability
2.6.3.	Driver attentiveness
2.6.4.	Other activities than driving task

- *The functional or dysfunctional requirements of paragraphs 2.4 to 2.10 must be tested by the technical service with “simple” evaluations. No requirement added in the test section.*
- *The verifications can be done by simple observations (type ok or not ok) or by tests with measurements*
- *Some tests may be carried out on open road at the discretion of the technical service for best representativeness:*
  - *For example: « The system shall become active only upon deliberate action by the driver and if the following condition is met: The vehicle is on roads where pedestrians and cyclists are prohibited and which, by design, are equipped with a physical separation that divides the traffic moving in opposite directions”).*

# ●●● Dynamic Driving Function

## ⇒ Overriding

- Test: apply a force in the steering control to override the automated lane keeping function.
- Pass: requirements of paragraph 2.4.8. are fulfilled.

## ⇒ Lane Keeping Functionality

### ⇒ Lane keeping and Stability

- Test: Drive in a lane at constant speed  $V_{max}$  with curved and straight sections to approach the max lateral acceleration.
- Pass: vehicle lane position fulfils the requirements of paragraph 2.5.1, specially if not parts of the vehicle, including it's device for indirect vision, pass the outside edge of the lane markings, and if no noticeable oscillation of the lateral position is present.

### ⇒ Object avoidance in the lane

- Test: Drive in a lane at constant speed  $V_{max}$  in which an object with a size small enough for the vehicle to pass without leaving the lane but large enough to assume damage to the vehicle has been placed .
- Pass: requirements from paragraph 2.5.1, 2.5.2 and 2.5.5.1 are fulfilled, specially if no collision between vehicle and object occurs.



Source: Euro NCAP

Introduction

Methodology

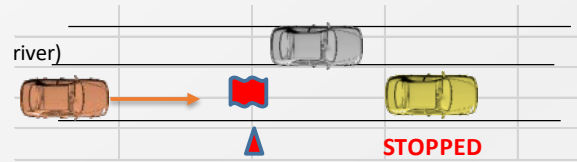
Test Scenarios

# Dynamic Driving Function

## ➤ Lane Keeping Functionality

### ➤ False reaction

- Test: Drive in a lane at constant speed  $V_{max}$  in which an object with a size too small to assume damage to the vehicle but with a size large enough to be detectable by the vehicle's sensors has been placed .
- Pass: no noticeable intervention of the automated lane keeping system occurs.



## ➤ Interaction with a preceding vehicle

### ➤ Following distance

- Test: Drive in a lane at constant speed  $V_{max}$  with curved and straight sections with a preceding target.
- Combinations:
  - Constant Speed: 10 km/h,  $V_{max}$ ,  $0,5 \times V_{max}$
  - Target: Vehicle, PTW.
  - Offset: 25%, 75%, 50%
  - Pass: requirements of paragraph 2.5.3.2 are fulfilled.

# ●●● Dynamic Driving Function

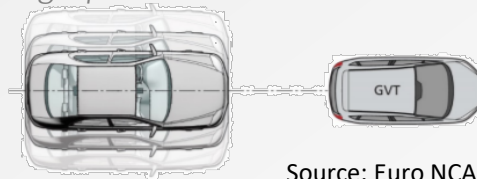
## ⚡ Interaction with a preceding vehicle

### ⚡ Following Stability

- Test: Drive in a straight lane at constant speed  $V_{max}$  with curved and straight sections with a preceding target that shall perform swerving motion with a defined amplitude and frequency.
- Pass: requirements of paragraph 2.5.1 are fulfilled and vehicle lane position fulfils the requirements of paragraph 2.5.1, specially if not parts of the vehicle, including it's device for indirect vision, pass the outside edge of the lane markings, and if no noticeable oscillation of the lateral position is present.

### ⚡ Preceding vehicle severe braking

- Test: Drive in a lane at constant speed  $V_{max}$  with curved and straight sections with a preceding target that will perform a deceleration maneuver with a mean fully developed deceleration of  $6 \text{ m/s}^2$  until standstill.
- Combinations:
  - Constant Speed:  $10 \text{ km/h}$ ,  $V_{max}$ ,  $0,5 \times V_{max}$
  - Target: Vehicle, PTW.
  - Offset: 25%, 75%, 50%
- Pass: requirements of paragraph 2.5.5.1 are fulfilled.



Source: Euro NCAP



# Dynamic Driving Function

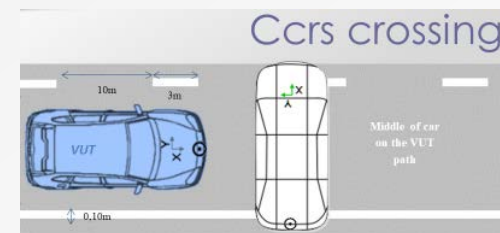
## Interaction with road users and objects in the lane

### Stationary road user

- Test: Drive in a lane at constant speed  $V_{max}$  with curved and straight sections in which there is an stationary target.
- Combinations:
  - Constant Speed: 10 km/h,  $V_{max}$ ,  $0,5 \times V_{max}$
  - Target: Vehicle, PTW.
  - Offset: 25%, 75%, 50%
- Pass: requirements of paragraph 2.5.4.1 are fulfilled (specially: collision avoidance without emergency maneuver)

### Large Obstacle

- Test: Drive in a lane at constant speed  $V_{max}$  with curved and straight sections in which an obstacle with a size so as to assume severe damage to the vehicle , such a vehicle parked orthogonal to the direction of traffic shall be positioned.
- Pass: requirements of paragraph 2.5.5.1 are fulfilled.



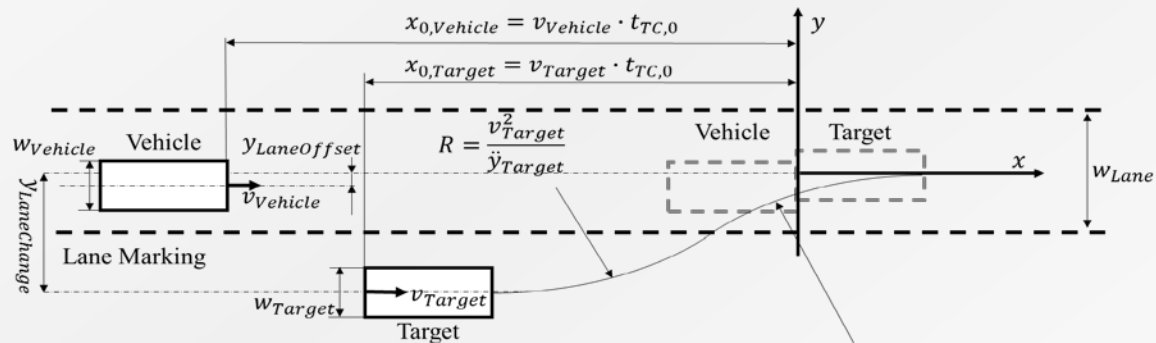


# Dynamic Driving Function

## Interaction with vehicles introducing into the lane

### Cut-In

- Test: The vehicle and target ( vehicle target and PTW) shall be travelling parallel and in the same direction, both on individual marked lanes and with their individual longitudinal speeds. When the longitudinal distance between the vehicles has reached a distance corresponding to a precise TTC the target shall perform a lane change composed of two segments of equal duration with the same lateral deceleration but opposed signs.
- Pass: The test is passed if the requirements from paragraph 2.5.5.2 & 2.5.4.2. are fulfilled ( specially there shall be no collision between vehicle and the second stationary target)



#### Properties of Vehicle:

Lane Offset  $y_{LaneOffset}$   
 Width of Target  $w_{Target}$   
 Width of Vehicle  $w_{Vehicle}$

#### Parameters of Test:

Lateral acceleration of Target  
 Lane change lateral distance  $y_{LaneChange}$   
 Beginning of Lane Change  $t_{TC,0}$   
 Speed of Target  $v_{Target}$   
 Speed of Vehicle  $v_{Vehicle}$   
 Lane Width  $w_{Lane}$

$$R = \frac{v_{Target}^2}{\ddot{y}_{Target}}$$

#### Assumptions:

Target x-Component independent of lateral movement

Introduction

Methodology

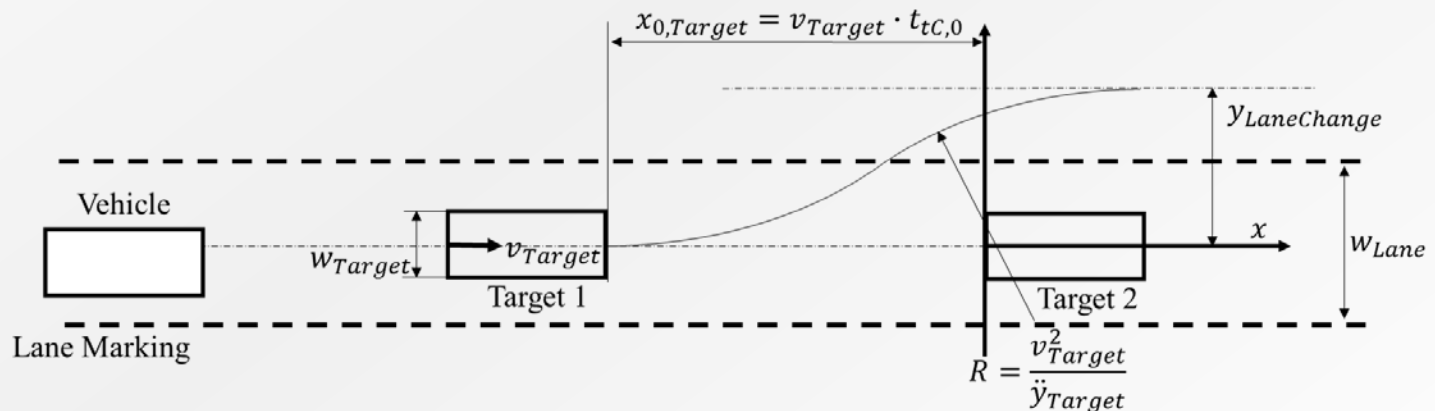
Test Scenarios

# Dynamic Driving Function

## Interaction with vehicles introducing into the lane

### Cut-Out

- *Test: The vehicle and a preceding target vehicle shall be travelling in the same lane with the speed of the target vehicle  $v_{Target}$  with a maximum of  $V_{max}$ . A secondary target object shall be positioned in the lane sufficiently ahead and being approached by the target vehicle. When the longitudinal distance between the target vehicle and the second stationary target has reached a distance corresponding to a TTC the target shall perform a lane change, composed of two segments of equal duration with the same lateral deceleration but opposed signs*
- *Pass: The test is passed if the requirements from paragraph 2.5.5.1 are fulfilled ( specially there shall be no collision between vehicle and the second stationary target)*

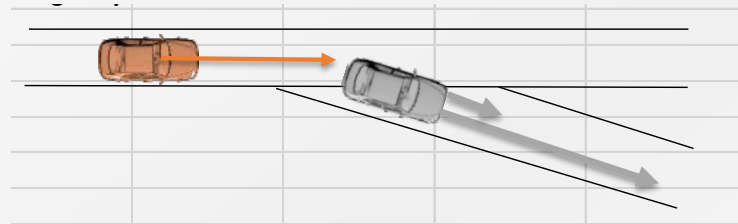


# ●●● Dynamic Driving Function

## 🚩 Open questions:

### 🚩 Is it necessary to add a Traffic way out test?

- Test: Drive in a lane at constant speed  $V_{max}$  with curved and straight sections with a preceding target that will perform a deceleration maneuver with a mean fully developed deceleration of  $[1 \text{ m/s}^2]$  at the same time that it leaves the lane with a lateral deceleration of  $[1,5 \text{ m/s}^2]$ .



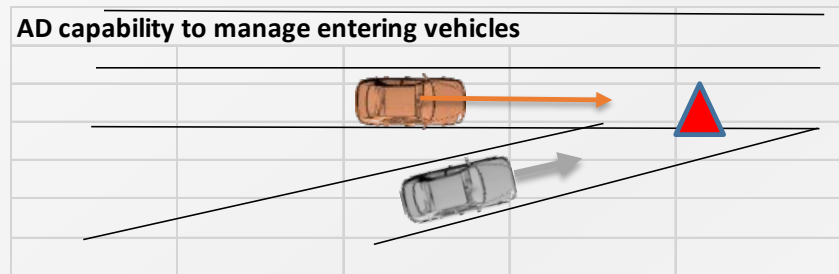
- If we add the possibility of different angles for stationary road user test, will it be already covered this situation by braking and stationary test?

# Dynamic Driving Function

## Open questions:

### Is it necessary to add a Traffic Insertion test?

- Test: Drive in a lane at constant speed  $V_{max}$  with curved and straight sections another target vehicle coming from an insertion lane goes into the lane of the ego vehicle resulting in a lateral impact.



- Would this scenario be covered by the cut in test scenario at low TTC of intrusion?

# Dynamic Driving Function

## Open questions:

Is it necessary to add a Field of view test?

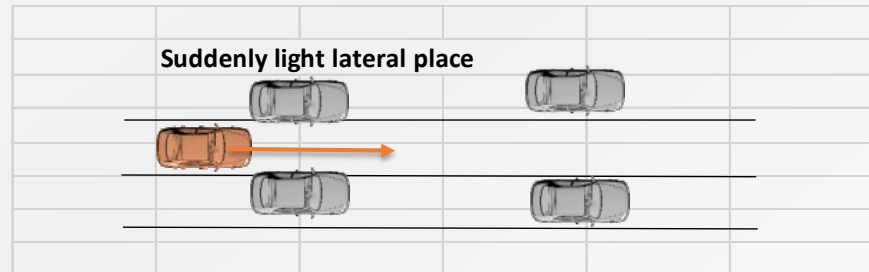
- Requirement

### 2.5.6. Sensing system

The ALKS vehicle shall be equipped with a sensing system such that it can determine the driving environment (e.g. road geometry ahead, lane markings) and the traffic dynamics across its own traffic lane, the traffic lane immediately to its left and to its right at least to the minimum detection range.

**Add: areas for field of view: include close proximity detection.**

- Test: Drive in a lane at constant speed  $V_{max}$  with curved and straight sections another target vehicle driving parallel and in the same direction get closer to the lane of the vehicle. The vehicle shall react to respect the minimal lateral distance with parallel traffic.



- To react to this situation correctly the car shall be equipped with lateral sensors, is it necessary to add this scenario?